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INSTRUMENT CAMERA FOR AIRCRAFT[1]

By R. H. Field[2]

Abstract

The camera is intended for photographing at regular predetermined intervals, or at desired instants, a number of instrument dials contained within the camera base. Records are made on 35 mm. film. The magazine is small and easily detachable to permit loading and unloading. Exposure is obtained by flashing lights, thus eliminating the need for a shutter. After each exposure the film is automatically reset.

Purpose

The camera here described was designed and built just prior to the present war and was intended to supplement the instrumental data ordinarily available in air photography for surveying purposes. Subsequently it has been found useful in special operations, e.g., where reliable instrument records are desired for the analysis of aircraft performance.

General Features

As the camera is self-contained, with the panel of instruments to be photographed placed within the base portion, it can be located at any convenient spot in the aircraft. When used in conjunction with air photography for mapping, the camera is operated from the intervalometer controlling the air camera, so that records are registered at the instant of exposure. If desired, the intervalometer can be eliminated and single exposures made under hand control.

When the operating impulse is given, lights flash inside the body, illuminating the instrument dials and so making the exposure. Immediately afterwards the film is wound from a motor-operated mechanism through a measured distance of one frame and is ready for the next exposure. The camera proper, containing the lens and film, is quite small and light. It is removable at once, after lifting two finger clips, and can be replaced by sliding into position and pushing down the clips. Hence it is not necessary to take the whole instrument into the dark room.

As completed the instrument camera is 18.5 in. high and 11.5 by 11.5 in. maximum plan dimensions. It weighs 23.5 lb. fully loaded and when containing a sensitive altimeter, air-speed indicator, watch, level-vials and Veeder counter, all mounted on a panel 10 by 10 in.

[1] *Manuscript received November 2, 1943.*

Contribution from the Division of Physics and Electrical Engineering, National Research Laboratories, Ottawa, Canada. Issued as N.R.C. No. 1180.

[2] *Metrologist.*

Description

Photographs of the Instrument Camera are reproduced in Figs. 1 and 2, while Fig. 3 is a drawing showing some details of the upper portion and the mechanism.

Body. The body rests on four shock absorbers, screwed to the floor or other convenient support. A duralumin rod is carried up from each shock-absorber to one corner of the supporting frame of the instrument panel. This frame is a square aluminium casting, the outer edge of which is seen above the lower, parallel, portion (Fig. 1) which is simply a sheet metal cover to house the instrument cases. From the frame casting, four duralumin rods, milled from square section, and forming the edges of a square pyramid, pass up to a second square aluminium casting, which is the base for the mechanism and film chambers and also is shaped to hold a small 12 v. series motor (taken from a Fairchild air camera). The sides of the pyramid are made from duralumin sheet with a lamp housing on the outside of each. One side is fitted with the door seen partly open in Fig. 1, giving access to the instrument panel for setting a counter, winding a watch, or changing lamps. For changing instruments the panel can be removed from the camera after detaching the lower sheet casing.

The instrument panel is painted dull black, while the rest of the interior not visible from the lens is painted white to help obtain uniform illumination.

Mechanism. In Fig. 1 the cover plate of the mechanism box is removed to show the mechanism, which is also illustrated in Fig. 3. The motor drives a wormwheel, 1, Fig. 3, which is coupled to its spindle through a spring-loaded saw-tooth clutch, so that the spindle can be wound independently of the motor by means of a knob, 2, outside the cover, e.g., after loading the magazine. The remote end of the spindle passes through a bearing and terminates in a positive, spring-loaded clutch that mates with a corresponding member on the film chamber and so winds the "exposed" spool. This clutch, as well as the similar one driving the measuring cam, is seen in Fig. 2.

The cycle of operations is initiated by an impulse given to the solenoid 3, Fig. 3, which was taken from a Fairchild Air Camera. Electric impulses, for regular operation, are received from a tapping key or an intervalometer, but the stem of the solenoid armature projects out through the casing so that, if desired, the cycle can be started by striking the stem with the finger. At the left end of the armature stem is an insulating block that strikes the phosphor-bronze switch contacts, 4, pushing them into contact. Switch 4 is in series with the lamp circuit, and so controls the flash used to give an exposure.

Furthermore, as the armature moves to the left it pulls over the double-toothed pawl, 5, which passes through a slot in the armature-stem and moves with it. At its upper end, pawl 5 is pinned to a block on the leaf spring 6, which is held in a deflected position when the pawl is locked on either of the stops. The left stop is about 1/32 in. higher than the right one, and the

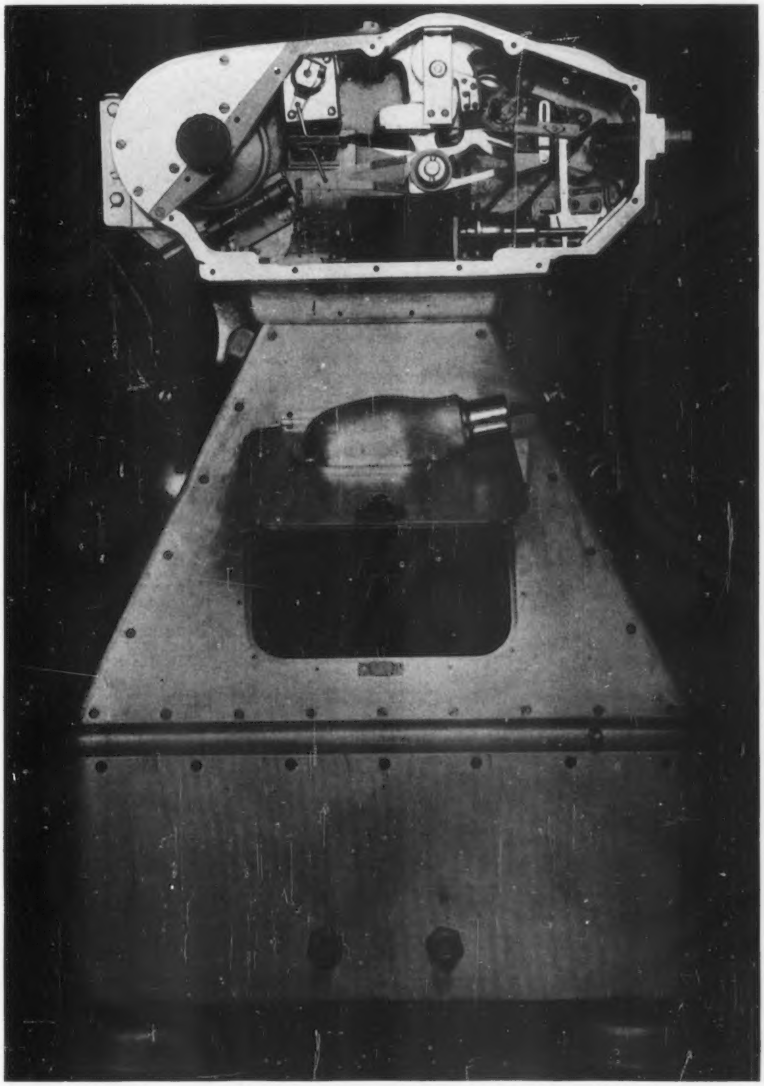

FIG. 1. *View of Instrument Camera from mechanism side, with door partly open. The three electric leads needed to operate the camera are brought in at the union connector seen at the upper right.*

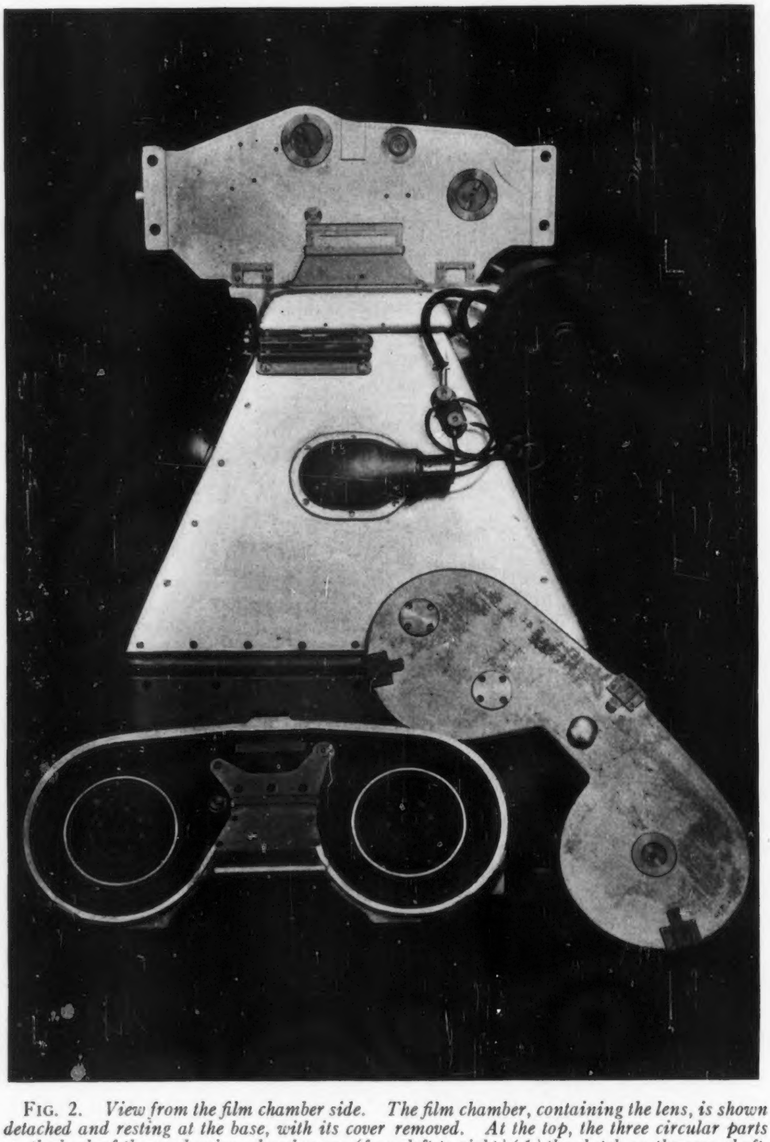

FIG. 2. *View from the film chamber side. The film chamber, containing the lens, is shown detached and resting at the base, with its cover removed. At the top, the three circular parts on the back of the mechanism chamber are (from left to right) (1) the clutch on the cam shaft, operated by the film sprocket visible in the film chamber, (2) the knob for adjusting the Veeder counter, and (3) the clutch for the motor-driven shaft turning the "exposed" spool. The two steel recesses, locating the film chamber, are visible at the base of the mechanism chamber.*

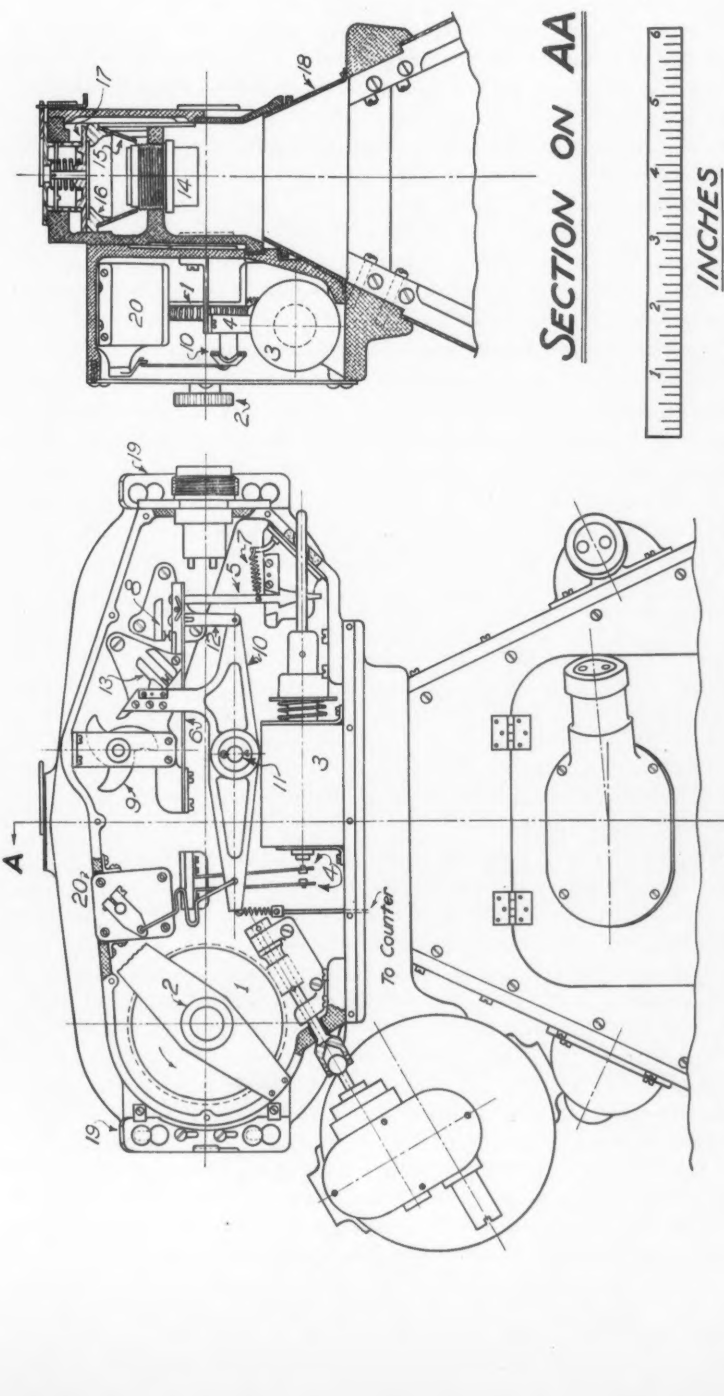

FIG. 3. *Left.* *Drawing of main features of mechanism, to illustrate operation.* *Right.* *Section through main axis, showing lens, exposure aperture, pressure plate, light-traps, and top of duralumin rods supporting the upper portion of the instrument camera.*

stroke of the solenoid-stem pulls the pawl from one to the other before it can slip up between the stops. This device, which ensures that the film remain stationary during exposure, was proposed by Mr. W. C. May (who built the camera) after experiments with a dashpot had failed to yield satisfactory performance.

At the conclusion of the impulse the armature returns to the right under the force of a light helical spring coiled around it, as well as that of the light spring, 7, hooked to pawl 5. This releases 5 from the left stop, and spring 6 draws it upwards between the two stops as 6 recovers its undeflected shape. In doing so, 6 closes the phosphor-bronze spring contacts, 8; this energizes the motor and causes the exposed portion of the film to be drawn away from the exposure gate in the film chamber.

Before entering the gate the unexposed film is drawn over a sprocket, seen in Fig. 2. The live spindle of this sprocket is coupled by the clutch, previously mentioned, to the three-leaved cam, 9, Fig. 3, in the mechanism chamber. The follower of this cam is a steel shoe on the lever, 10. As the cam rotates in a counter-clockwise direction under the action of the film, 10 rotates about its pivot, 11, in a clockwise sense. A link, 12, having a slotted hole at its upper end is thus made to deflect the leaf-spring 6. Just before the follower is about to jump over a corner of the cam face, pawl 5 engages with the right stop under control of the light spring 7, thus maintaining 6 in the deflected position.

In the power line from the battery to the motor there is a second phosphor-bronze spring contact switch, 13, in parallel with 8. The mechanism is adjusted so that 8 is made when the spring 6 is free and 13 is made just before 8 opens owing to the deflection of 6. Insulated blocks on 6 and 10 press the respective switch elements into contact. When the follower slips over the corner of 9, switch 13 opens and the motor stops. The film has now been wound through the correct amount and is ready for the next exposure.

The flashing lights are 21 candle power six volt automobile bulbs, which were found to build up to the correct brightness under the 12 volt impulse from the solenoid-operated switch 4. In the final adjustment of the exposure, the iris diaphragm of the lens was adjusted by trial.

Film Chamber. The camera proper, or film chamber, is seen detached, with the lid removed, at the lower part of Fig. 2. It is an aluminium casting, and contains a Bausch and Lomb "Raytar" lens of 25 mm. focal length, 14, Fig. 3. Immediately above the lens a thin metal cone, 15, is fixed to the steel bracket, 16, in which the aperture is machined. It protects the film in the chamber from stray light. The surface of 16 in contact with the film is burnished, and a spring-loaded burnished steel plate, 17, holds the film flat. When the film is being removed or loaded, a lever outside the film chamber is utilized to release the pressure plate. Three finger catches, seen in Fig. 2, hold the lid in place, and no difficulty is experienced in loading and unloading in the dark, once this operation has been practised in the light.

No serious difficulty was encountered in making the film chamber light-tight and at the same time a free fit. When inserted into place it slips over a sheet metal pyramid, 18, Fig. 3, studs enter four holes in the end flanges of the mechanism chamber, seen in Fig. 2, and final location is accomplished by means of steel shoes engaging in steel sockets of inverted U-shape, visible on either side at the base of the chamber. When in place two plates, 19, Fig. 3, on the flanges, with keyhole slots, lock into grooves on the four studs.

Operation

The camera is fitted with two level vials on the outside of the body which are made to register with any level vials on the instrument panel inside. This permits datum level to be set in the aircraft by adjusting the camera on the shock-absorbers. It is also fitted with two Veeder counters, one, 20, Fig. 3, is visible from outside at the top of the mechanism chamber and the other is on the instrument panel where its indications are photographed. The counters are operated from lever 10, and the dual arrangement permits the serial number of a picture to be logged. As a further means of identifying any desired photograph, a knob outside the body, at about the plane of the instrument panel, if depressed, pushes into the field a hinged white vane, which is registered on the desired photograph. The vane returns to the side of the panel under spring action when pressure is released.

As illustrated, the camera is fitted with connections for static and pitot heads, but, as the lower cover is merely plywood and duralumin sheet, there is no difficulty in fitting any desired instrument connection.

The minimum exposure interval is determined by the time taken for the motor to wind the film through one frame and in experiments it was found possible to make records at intervals of 5 sec.

The image of the instrument panel measures just under 1 in. square, and if suitable film and development technique are adopted, the indications of the fine centre seconds sweep hand of a watch can be easily read with the aid of a magnifier or projector. The correct image density for a given type of film is found from trial after adjusting the iris diaphragm in the lens.

Acknowledgments

Mr. W. C. May, of the National Research Council Instrument and Model Shops, built the camera, and while doing so contributed a number of ideas that added greatly to the successful performance of the mechanism. Dr. L. G. Turnbull, of the Metrology Section, assisted in the development, and carried the instrument through its "teething" stages.

DRIED WHOLE EGG POWDER

X. THE EFFECT OF ADDED SUBSTANCES ON KEEPING QUALITY[1]

By Jesse A. Pearce[2], A. H. Woodcock[3], and N. E. Gibbons[4]

Abstract

Dried whole egg powders, treated with a number of substances prior to drying, were stored at temperatures from 23.9° to 47.7° C. Deterioration in quality was assessed by fluorescence measurements, supported in some instances by palatability tests.

Fluorescence development in powders containing sodium chloride in combination with either citric or lactic acid was more rapid than in the control powder. The effect was less marked when any of these substances was used alone. The addition of 15% sucrose was more effective in inhibiting fluorescence development at 23.9° C. than at 37.2° C. but had no effect at 47.7° C. The addition of 0.2% sodium bicarbonate, an amount that did not affect the flavour of the powder, retarded deterioration as indicated by fluorescence and palatability tests. Other alkaline salts studied (sodium acetate, benzoate, citrate, salicylate, and tartrate) had no effect.

Introduction

Previous investigations (3, 5) have shown the amount of fluorescent material in dried whole egg powder to be inversely related to the quality. Decomposition of the protein portion of the dried powder is believed to be a factor contributing to fluorescence development (2). Observations recorded elsewhere (3, 6) have indicated that oxidation of the fat is not directly responsible for spoilage in egg powder. As a result, this investigation is concerned with the addition to egg melange of materials that may retard deterioration of the protein fraction.

Substances likely to extend the storage life of egg powders were indicated by other work. It has been observed that fluorescence is greater in acid than alkaline solutions (4). This, coupled with the decrease in pH accompanying spoilage in egg powders (5, 7), suggested that if the powder could be maintained in an alkaline condition spoilage might be retarded. However, contradictory evidence appeared during the gas storage of egg powder. Nitrogen did not retard fluorescence development but carbon dioxide appeared to do so (9), indicating that the maintenance of acid conditions in the powder may retard spoilage. The effect of sodium citrate in stabilizing milk powder protein (1) led to its use and to the use of citric acid in this study.

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Contribution from the Division of Applied Biology, National Research Laboratories, Ottawa. Issued as Paper No. 104 of the Canadian Committee on Food Preservation and as N.R.C. No. 1185.

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[3] *Biophysicist, Food Investigations.*

[4] *Bacteriologist, Food Investigations.*

Experimental

The first experiment was of a preliminary nature to study the effect of the addition of the following materials on keeping quality of egg powder: lactic and citric acids, sodium bicarbonate, and sodium chloride alone and in the presence of lactic and citric acids. It was felt that to be suitable, any material added should be effective at concentrations that did not affect palatability of the cooked melange and hence, of the reconstituted powder. Palatability tests showed that the following were the maximum quantities permissible: lactic and citric acid, to a pH of about 6.7, sodium chloride, 0.3%, and sodium bicarbonate, 0.2%. Egg melange was then treated with these amounts and dried in an experimental spray drier (10). Subsequent to drying the powders were stored at 23.9°, 32.2°, and 47.7° C. (75°, 90°, 118° F.) and samples were removed for analysis during a period of four weeks.

The addition of 0.2% of a number of alkaline salts (sodium acetate, sodium benzoate, sodium bicarbonate, sodium citrate, sodium salicylate, and sodium tartrate) and 15% sucrose was then investigated. The quantity of salt added caused no significant difference in palatability of the reconstituted powder. The quantity of sucrose added would change the product to a mixture suitable only for baking purposes. These powders were stored for seven and one-half weeks at 23.9°, 37.2°, and 47.7° C. (75°, 99°, and 118° F.).

Fluorescence measurements on the stored powders by the method described (3) are recorded as photofluorometer units on the Coleman photofluorometer. Palatabilities of some of the powders were determined as previously described (3).

Results

Fig. 1 shows the results obtained in the preliminary experiment. Unfortunately, some extraneous factor, possibly differences in moisture content, confused the significance of the results at 23.9° and 32.2° C. The moisture content of the powders varied between 2.7 and 3.8%. The control and the powder containing sodium bicarbonate had moisture contents of 2.9 and 3.8% respectively. While moisture content was known to affect fluorescence development (7, 8), it was felt that to prolong storage life effectively the substance added must have a greater effect than could be attributed to the slight differences resulting in moisture variation within this range.

At 47.7° C. the effect of added substances could be more readily observed. The characteristic shape of the curves had been observed previously (7, 8) and was believed to be the result of two or more reactions involved in the production of fluorescing substances in stored egg powder. None of the added materials seemed to alter the initial rapid increase in fluorescence values, but the presence of both salt and acid in the same powder accelerated the second phase of fluorescence development. This was also observed but to a lesser extent in powders containing salt or lactic or citric acid alone. The addition of sodium bicarbonate appreciably retarded the development of fluorescing substances, although this powder had the highest moisture content.

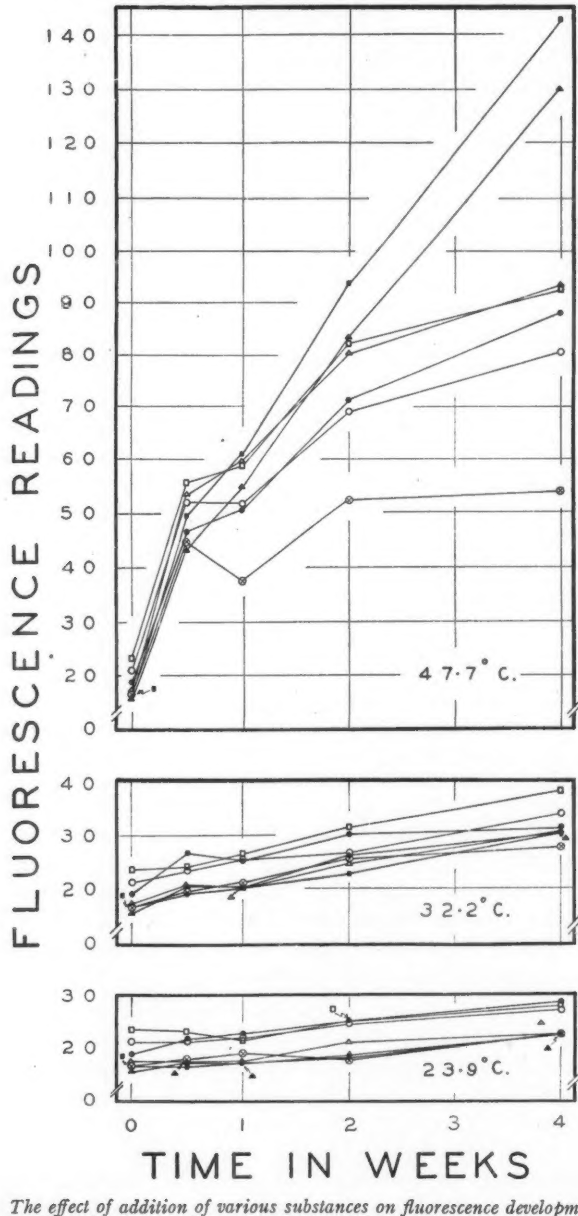

FIG. 1. *The effect of addition of various substances on fluorescence development in dried egg powder.* ■ *Powder from melange adjusted to pH 6.8 with lactic acid and containing 0.3% sodium chloride.* ▲ *Powder from melange adjusted to pH 6.7 with citric acid and containing 0.3% sodium chloride.* ● *Powder from melange containing 0.3% sodium chloride.* ⊕ *Powder from melange containing 0.2% sodium bicarbonate.* ○ *Control.* △ *Powder from melange at pH 6.8 with citric acid.* □ *Powder from melange at pH 6.7 with lactic acid.*

Further evidence that sodium bicarbonate was effective in maintaining quality in the stored powder is evident in the palatability changes occurring during the four week period at 47.7° C. From an original score of 8.0 the control powder, the powder containing lactic acid and sodium chloride, and that with sodium bicarbonate decreased 3.6, 4.0, and 2.9 palatability units respectively.

The effectiveness of sodium bicarbonate was confirmed and the effect of other alkaline salts and sucrose was determined in the second experiment. The moisture contents of the powders used in this experiment varied between 1.8 and 2.6%. The control and the powder containing sodium bicarbonate had almost identical moisture contents, 2.1%, while the powder containing sucrose contained 1.8% moisture, on the basis of total solids.

Fig. 2 indicates the results obtained for the control powder and the powders containing sodium bicarbonate and sucrose. Egg powders containing the other alkaline salts developed fluorescence values in a manner very similar

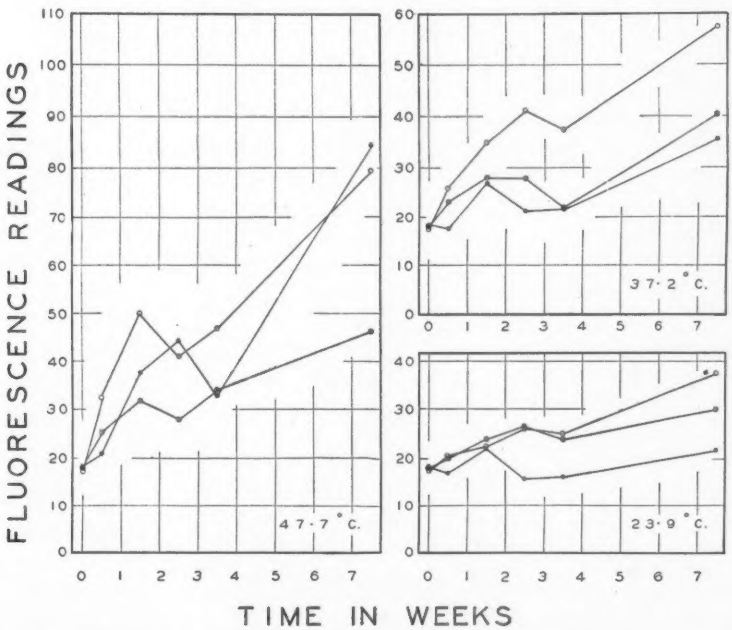

FIG. 2. *The effect of sodium bicarbonate and sucrose on fluorescence development in dried egg powder.* ○ *Control.* ● *15% Sucrose added to melange before drying.* ⊕ *0.2% Sodium bicarbonate added to melange before drying.*

to the control (Table I) and, to avoid confusion, the curves were omitted in the graphs. It is evident that, for the period studied, the effectiveness of sucrose in preventing fluorescence development at 23.9° C. decreased with

TABLE I

FLUORESCENCE VALUES OF DRIED WHOLE EGG POWDERS CONTAINING 0.2% ALKALINE SALTS, AFTER SEVEN AND ONE-HALF WEEKS' STORAGE

Added salt	Storage temperature (°C.)		
	23.9	37.2	47.7
Control	37.6	59.6	79.4
Sodium acetate	37.6	60.2	80.9
Sodium benzoate	36.0	62.8	74.4
Sodium bicarbonate	30.1	40.5	46.5
Sodium citrate	37.8	53.5	72.4
Sodium salicylate	39.2	60.2	90.7
Sodium tartrate	40.2	56.8	71.6

increase in temperature whereas the opposite behaviour was observed for sodium bicarbonate. At 37.2° C. and 47.7° C. the increase in fluorescence values of powders containing sodium bicarbonate was about one-third that of the control powder after seven and one-half weeks' storage.

Palatability tests could not easily be made on the samples containing sucrose, but such comparisons supported the fluorescence measurements on the other samples. At storage temperatures of 23.9°, 37.2°, and 47.7° C., the palatability reduction over the seven and one-half weeks' storage period was 2.5, 4.0, and 5.5 for the control samples and 0.5, 2.5, and 3.5 palatability units for samples containing sodium bicarbonate. Powders containing the other alkaline salts decreased in palatability score at about the same rate as the control powder.

The foregoing results indicate that substances added to egg melange can prolong the storage life of the dried powder. Of the materials studied, sodium bicarbonate was effective at a concentration that did not affect the palatability of the egg powder. Moreover, it is apparent that this effect does not result from the presence of sodium ion nor is it a result of increased pH. It is suspected that maintaining the concentration of carbonate ion may be responsible for the protective action of sodium bicarbonate.

References

1. HOLLENDER, H. A. and TRACY, P. H. J. Dairy Sci. 25 : 249-274. 1942.
2. PEARCE, J. A. Can. J. Research, D, 21 : 98-107. 1943.
3. PEARCE, J. A. and THISTLE, M. W. Can. J. Research, D, 20 : 276-282. 1942.
4. PEARCE, J. A., THISTLE, M. W., and REID, M. Can. J. Research, D, 21 : 341-347. 1943.
5. THISTLE, M. W., PEARCE, J. A., and GIBBONS, N. E. Can. J. Research, D, 21 : 1-7. 1943.
6. THISTLE, M. W., REID, M., and GIBBONS, N. E. Can. J. Research, D, 21 : 267-269. 1943.
7. WHITE, W. H. and THISTLE, M. W. Can. J. Research, D, 21 : 194-202. 1943.
8. WHITE, W. H. and THISTLE, M. W. Can. J. Research, D, 21 : 211-222. 1943.
9. WHITE, W. H., THISTLE, M. W., and REID, M. Can. J. Research, D, 21 : 271-276. 1943.
10. WOODCOCK, A. H. and TESSIER, H. Can. J. Research, A, 21 : 75-78. 1943.